Determinants of Corporate Investment: Post Liberalization Panel Data Evidence from Indian Firms

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Abstract

The paper models alternative investment-accelerator relationships within the neoclassical theory of Jorgenson followed by firm level panel data estimation and empirical test for other determinants of corporate investment e.g., internal liquidity, profitability, and firms' financial strength. Athey and Laumas (1994) claimed that internal liquidity had replaced market demand in Indian firm level investment. Others indicate presence of finance constraints in Indian private sector investment activities; Kumar *et al*. (2001, 2002). Therefore, in the immediate aftermath of liberalization *whether market demand had still not been important when availability of internal liquidity, firms' profitability and creditworthiness are considered*. We consider Indian manufacturing firms in the post-reform period of 1990s. There is significant support for the investment–accelerator relationship. Internal liquidity is relatively more important than profitability when it comes to firms' investment decisions. There is also evidence that credit worthiness of firms to outside creditors is important for firm investment decision.

Keywords: Business fixed investment, sales accelerator, retained earnings, profitability, financial strength.

JEL classification: C23; D21; E13; E22; G31; G32.

I. Introduction

Over the last decade and half there has been a widespread change of opinion in India about the role of the state vis-à-vis private enterprises in promoting economic growth. Underlying this opinion is the belief that resources will be used more productively if they are transferred to the private sector. Since the expansion of public investment is usually constrained as part of fiscal austerity measures embodied in structural adjustment program, the required recovery of investment has to come largely from the private sector. The behavior of private investment has therefore, become a major focus of attention in developing countries like India in assessing the reform outcome.

Two macroeconomic issues have become important in the context of investment activities of a developing country like India: the role (or lack) of FDI in corporate investment activity, and the effects of public and private savings on aggregate investment.[1] In India, since 1991 the central government introduced a number of changes in the country's regulatory policies under the SAP. As a result, the government-approved FDIs increased substantially.[2] While the investment approvals show a promising picture, a point of considerable anxiety is the slow pace of actual inflows. FDI inflows do not start flowing immediately after the approval. There exists a time lag between approvals and inflows, especially for large and long gestation projects. Official figures indicate that inflows constitute about one-fifth of the approvals (Economic Survey, 1999). Therefore, *in the first decade of liberalization FDI was not a major source of external finance to corporate investment in India*. One survey by Institute for Studies in Industrial Development (ISID) in 1994 revealed that the major consideration for the Indian companies to enter into a collaboration agreement is to get superior technology. Access to foreign funds has a very low priority. A major focus of the Indian liberalization policies had been to dismantle the complex web of controls that severely constrained the emergence and operation of the private entrepreneurs.[3] This process has had maximum impact on the industrial sector, as it has changed its business environment and future growth dynamics. The growth in industrial output is

[1] FDI flows to developing countries are primarily supported with the view that (i) it supplements domestic savings and thereby promote economic growth and employment, and (ii) encourage transfer of technology to help the host countries to break out of the vicious circles of underdevelopment — low levels of savings and investment.

[2] For example, during the first year of liberalization, i.e., 1991-92, approved investment shot up to Rs. 534 cr. from Rs. 128 cr. in 1990, i.e., a growth rate of 317%. By March 1998, official estimates indicate that the approved FDI was of the amount of Rs. 1, 58, 770 crores. See, Ministry of Industry, India, *SIA Newsletter*, April 1998.

[3] The licensing regime established under Industries Development and Regulation Act (IDRA) in 1951 coupled with import restrictions controlled the private sector decisions at every stage, from entry into an industry to capacity expansion, to choice of technology, even output mix and import content. For details, see Ahluwalia (1985).

primarily associated with new investment in plant and machinery. If firms are confident that demand will remain buoyant, they invest more in new plant and machinery which generates even more demand.

There are a few studies using pre-reform as well as post-liberalization data on private investment in India. See for example, Athey and Laumas (1994), Eastwood and Kohli (1999), Athey and Reeser (2000), Kumar *et al.* (2001), and Athukorala and Sen (2002), among others. The present study is another attempt to learn more about the empirical determinants of private corporate investment activity in India particularly during the post-liberalization period. The aim is to examine the role of *accelerators* and *financial variables* affecting business fixed investment and try to disentangle their individual importance. In other words, we attempt to point out that both the demand factors and firms' internal funds are important to Indian manufacturing firms' investment activities in the post-liberalization period.

Section II builds our theoretical models. It also discusses the theoretical issues related to capital market imperfections and the relationship between finance constraints and investment. Section III gives a brief review of existing empirical literature. Section IV explains the data set, variables and the empirical models used in this study. Section V describes the estimation method. The regression results with accelerator(s) and liquidity are discussed in Section VI followed by the empirical evidence on profitability and financial strength in Section VII. Finally, concluding remarks are given in Section VIII.

II. Theoretical Model

Jorgenson (1963) presented the neoclassical theory of optimal capital accumulation. Consider a representative firm employing only two factors of production, namely labor (*L*) and capital (*K*) to maximize the present value of the stream of its net profit (π) over an infinite horizon. The dynamic optimization problem can be stated as maximization of π given a well-behaved neoclassical production function:

1.1 Maximize $\pi = \int_0^\infty e^{-rt}[PY - wL - P_I I - \tau\{PY - wL - (\theta\delta P_I + zrP_I)K\}]dt$

where $Y = Y(L,K)$ with $Y_L, Y_K > 0$ and $Y_{LL}, Y_{KK} < 0$; and $I = \dot{K} + \delta K$

P is the exogenously given output price, Y is the output level, w is the given wage rate P_I is the purchase price of capital goods, I is gross investment. τ ($0 < \tau < 1$) is the profit tax rate and 'θ' proportion of the firm's depreciation cost and 'z' proportion of its interest cost are "chargeable against income for tax purposes"; the depreciation rate is δ and the interest cost of loan is r.

Assuming a Cobb-Douglas production function ($Y = AL^{\alpha} K^{\beta}$ where A, α and β are the technological coefficients), we will obtain the capital demand function which using time subscripts can be written as

1.2 $\quad K_t = \dfrac{\beta P_t Y_t}{\widehat{c}_t P_t^I}$ where $\widehat{c}_t = \dfrac{[(1-\tau\theta)\delta + (1-\tau z)r]}{(1-\tau)}$ is the *real* user cost of capital.

The desired capital stock of the firm can be obtained from 1.2:

1.3 $\quad K_t^* = \mu_t Y_t$ where $\mu_t = \left(\dfrac{\beta P_t}{P_t^I \widehat{c}_t}\right)$ is time dependent capital-output ratio.

Chenery (1952) and Koyck (1954) developed the Flexible accelerator model of investment behavior. In this model, at any given time period, a firm can only close a fraction of the gap between the desired and its inherited capital stock. Therefore, net investment function (I^N) follows the following adjustment rule:

1.4 $\quad K_t - K_{t-1} = \lambda\ [K_t^* - K_{t-1}],\ 0 < \lambda < 1$

λ is known as the 'speed of adjustment' of capital which depends upon various factors like construction time, adjustment costs, delivery lags and so on. It is however, assumed to remain constant over time.

Jorgenson and his associates distinguished between the (traditional) accelerator models and their neoclassical conceptualizations. See for instance, Jorgenson and Stephenson (1967), Jorgenson and Siebert (1968), and Jorgenson (1971). We argue that accelerator principles can also be obtained from within the neoclassical framework; thereby, alternative neoclassical investment-accelerator relationships can be formulated. Four different accelerator models will be obtained from 1.2. Specific rules will be suggested to describe the relationship between rate of net investment and rate of change in the desired capital stock of the firm.

The proposed models are identified as nominal or real accelerator models depending upon whether nominal or real output determines investment. These models are

(a) rate of *real* net investment as a function of rate of change in *nominal* output of the firm and rate of change in *nominal* user cost of capital: *Neoclassical Nominal Accelerator Model I*;

(b) rate of *nominal* net investment as a function of rate of change in *nominal* output of the firm and rate of change in *real* user cost: *Neoclassical Nominal Accelerator Model II*;

(c) rate of *real* net investment as a function of rate of change in output and rate of change in *real* user cost *where real capital is expressed in terms of the unit of output*: *Neoclassical Real Accelerator Model I*; and

(d) rate of *real* net investment as a function of rate of change in output, rate of change in *real* user cost, and *the difference between inflation in the output price and inflation in investment good price*: *Neoclassical Real Accelerator Model II*.

Therefore, we derive three *real* net investment functions and one *nominal* net investment function within a neoclassical framework.[4]

Rule I: $i_t^N = \frac{dK_t}{K_t dt} = \overline{\lambda} \frac{dK_t^*}{K_t^* dt}, \ 0 \langle \ \overline{\lambda} \ \langle 1$

i_t^N is the rate of (real) net investment. The proportionality factor $\overline{\lambda}$ is similar to the 'speed of adjustment' of real capital stock λ in the flexible accelerator model.

Let us now derive the neoclassical models in algebraic terms. Rewriting 1.3 gives us

1.5 $$K_t^* = \frac{\beta V_t}{c_t}$$

where $V_t = P_t Y_t$ is the nominal output of the firm and c_t is the *nominal* user cost of capital that varies over time with investment good's price, tax rate, etc. Taking natural logarithm of 1.5 and then differentiating with respect to time, Rule I allows us to obtain

[4] The neoclassical nominal accelerator models are based on the presumption that changes in the nominal value of output reflect a firm's expectations about similar changes in its sales proceeds. These changes then bring about corresponding adjustments in the desired capital stock of the firm. In the Neoclassical Nominal Accelerator Model I, the effect on real net investment is considered. On the other hand, Neoclassical Nominal Accelerator Model II considers the effect of nominal output changes on the nominal value of net investment. In this latter model it is being hypothesized that firms wish to attain nominal values of desired capital stock, hence undertake nominal net investments.

$$1.6 \qquad i_t^N = \bar{\lambda}\left(v_t - \overline{\overline{c}}_t\right)$$

where $v_t = \frac{1}{V_t}\frac{dV_t}{dt}$ is the nominal output accelerator variable and $\overline{\overline{c}}_t = \frac{1}{c_t}\frac{dc_t}{dt}$. 1.6 describes the Neoclassical Nominal Accelerator Model I where *the current rate of change in nominal output (along with the current rate of change in the nominal user cost of capital) determine the present rate of real net investment*.

Rule II: $\tilde{i}_t^N = \frac{d\tilde{K}_t}{\tilde{K}_t\, dt} = \tilde{\lambda}\frac{d\tilde{K}_t^*}{\tilde{K}_t^*\, dt},\ 0\langle\tilde{\lambda}\langle 1$

where $\tilde{K}_t = P_t^I K_t$ is the actual nominal capital stock of a firm. $\tilde{\lambda}$ is the acceleration coefficient.

We rewrite 1.3 as

$$1.7 \qquad \tilde{K}_t^* = \frac{\beta}{\hat{c}_t}V_t$$

Using a similar method, we obtain the Neoclassical Nominal Accelerator Model II:

$$1.8 \qquad \tilde{i}_t^N = \tilde{\lambda}\left(v_t - \overline{\overline{\hat{c}}}_t\right) \text{ where } v_t \text{ as defined above and } \overline{\overline{\hat{c}}}_t = \frac{\dot{\hat{c}}_t}{\hat{c}_t}$$

In this model, *the current rate of change in the real user cost of capital along with the current rate of change in nominal output determine the present rate of nominal net investment.*

We now consider two versions of the Neoclassical Real Accelerator Model. Model I expresses capital in terms of the unit of output. This has been quite common in the existing empirical literature where both the value of capital stock and the sales revenues have been deflated by a general price index. See, for instance Bilsborrow (1977), and Fazzari and Athey (1987). However, Neoclassical Real Accelerator Model II follows a conventional theoretical practice where both capital and output are measured in their respective units.

Rule III: $\hat{i}_t^N = \frac{d\widehat{K}_t}{\widehat{K}_t dt} = \hat{\lambda}\frac{d\widehat{K}_t^*}{\widehat{K}_t^* dt},\ 0\langle\hat{\lambda}\langle 1$

where $\widehat{K}_t = \frac{P_t^I K_t}{P_t}$ is actual real capital and $\widehat{K}_t^*$ is desired real capital, both expressed in terms of the unit of output. $\hat{\lambda}$ is the adjustment speed of real net investment.

As before, we first rewrite 1.3 as

1.9 $$\widehat{K_t^*} = \frac{\beta Y_t}{\widehat{c_t}}.$$

Then, using Rule III we obtain the following:

1.10 $$\widehat{i_t^N} = \hat{\lambda}\left(y_t - \overline{\overline{\widehat{c_t}}} \right)$$

where y_t is the rate of change in output and $\overline{\overline{\widehat{c_t}}}$ as defined above. 1.10 describes the Neoclassical Real Accelerator Model I where *the present rate of real net investment is determined by the current rate of change in output and real user cost*.

For Neoclassical Real Accelerator Model II, rewrite 1.3 again as

1.11 $$K_t^* = \frac{\beta}{\widehat{c_t}}\left(\frac{P_t}{P_t^I} \right) Y_t$$

Using Rule I, we have the following:

1.12 $$i_t^N = \overline{\lambda}\left[y_t + \left(\pi_t - \pi_t^I \right) - \overline{\overline{\widehat{c_t}}} \right]$$

where π_t and π_t^I are the respective inflation rates of output and investment good. Therefore, in this *real* accelerator model, *the difference between the inflation rates will also matter unless they are equal to each other, beside the present rate of change in output and real user cost.*[5]

For further details on alternative investment-accelerator functional relationships, see Bhattacharyya and Sinha (2004).

However, there are some valid criticisms of the accelerator models of investment. Among others, an important one is that financial constraints of firms do not play any role. The same is true even for the neoclassical theory of capital accumulation. These theories rely heavily upon the assumption that the firm has no financial constraint. Absence of such a constraint can exist in a perfectly competitive capital market. Modigliani and Miller (1958) pointed out that in such a situation the capital structure of a corporate firm is irrelevant to its investment decisions. In a

[5] Often in theoretical discussions, authors assume equal inflation rate for output and investment goods. It is also quite common to assume static price expectations. See, for instance Hall and Jorgenson (1967), Scarth (1982) among others.

world of perfect capital market, investment differs across firms only due to the differences in their *expected future profitability* of the prospective investment projects.

But in reality, there may exist different sorts of imperfections in the capital market. The capital market may be segmented, catering to the needs of a selected few. There may be credit rationing. Consequently, firms will not only undertake a smaller amount of investment, at the same time they may lower their desired capital stock. The capital structure (debt-equity ratio) and the ownership structure (ratio of inside to outside equity holding) will have their respective discriminatory roles in the determination of the realized amount of investment. Therefore, firms' investment and financing decisions become interdependent.

II.1 Asymmetric Information, Agency Costs and Transaction Costs

In the theoretical literature, three alternative factors (not always independent of each other) are commonly cited which create a wedge between the cost of external and internal finance. These are asymmetric information, managerial agency problems and transaction costs.

Theoretical discussions on asymmetric information attempted to demonstrate how information costs in the presence of internal resource constraints of a firm affect its fixed investment activities. See for instance, Fazzari and Peterson (1993), and Hubbard (1998). Empirical studies have attempted to isolate the effects of information and internal resources on investment, independent of changes in investment opportunities, see Whited (1992) and Audretsch and Elston (2002).

Higher interest costs can cause relatively good firms with safer projects to leave the applicant pool (*adverse selection*). It can also induce firms to undertake riskier projects with expected higher returns (*moral hazard*). The net effect of the two can further aggravate the already existing cost disadvantage and the liquidity problem for the investing firms.

An internally liquidity constrained firm either facing credit constraint or higher interest cost finds it difficult to obtain funds from other sources, in particular the debt and equity market. Because there may arise agency costs of equity and debt financing; Jensen and Meckling (1976).

Apart from asymmetric information and managerial agency problems, another important factor contributing to financial stringency is transaction costs. "The TCE (transaction cost economics) approach to corporate finance examines individual investment projects and distinguishes among them in terms of their asset specificity characteristics", Williamson (1988, p. 579, parenthesis mine). Let us assume that initially the only form of external finance available to the firm is debt. Debt financing requires the debtors to make regular interest payments, meet certain liquidity tests, set up sinking funds, and repay the principal at the expiry date. Failure to make scheduled payments will result in liquidation of firm's physical assets. Debtors will try to raise funds through sale of its assets. It will depend upon the degree of *redeployability* of firm's assets. "The upshot is that whereas highly redeployable assets will be financed with debt, equity is favored as assets become highly non-redeployable", Williamson (ibid, p. 581).

Theoretical research has led to the empirical hypothesis that financial variables such as the availability of internal funds, access to external finance, and functioning of credit markets affect capital formation of firms. The empirical literature claims that internal finance is the most important source of funds for capital spending at the firm level.

III. Review of Empirical Literature on Indian Data

The first comprehensive study on the investment behavior of Indian firms was by Krishnamurty and Sastry (1975) using data provided by the RBI and the Stock Exchange Official Directory. Their study suggested that the accelerator theory was important for Indian industries. Later, Athey and Laumas (1994) using panel data over the period 1978-86, examined the relative importance of sales accelerator and alternative internal sources of liquidity in investment activities of 256 Indian manufacturing firms. They found that when all the selected firms in the sample were considered together, current values of changes in real net sales, net profit, and depreciation were all significant in determining capital spending of firms. The authors suggested that, because of Indian government's policy to promote small enterprises internal funds were relatively more important for large firms. Eastwood and Kohli (1999) considered Indian public limited companies of the small-scale industry during the period 1965-78. They concluded that small firms faced a relatively rigid financial environment where not only the supply of external credit was fixed irrespective of firms' investment demands, but there were effective constraints regarding the usage of the funds as well. The study demonstrates that small and large firms in

India faced different financial environment during 1965-78. Athey and Reeser (2000) using a panel of 142 firms from 7 industrial groups in India over the period 1981-96 found that cash flow is more important for firms with limited access to capital markets. *Is there still a binding finance constraint on firm investment activities in India?* In another recent study Kumar *et al*. (2001) attempted to investigate the presence of finance constraints among investing firms in the post-liberalization period 1993-98, using Indian manufacturing firms as a case study. The authors suggested that exporting firms faced less restrictive finance constraints than their domestic counterparts. The sales accelerator was significant for domestic and small firms. It was not found significant for the exporting firms. Another important study in the Indian context is of Athukorala and Sen (2002) who examined the determinants of private corporate investment using data for the period 1954-96. These authors found lagged change in real bank credit to be an important source of external finance to Indian firms. Public investment has a strong complimentary relationship with private corporate investment in India.

IV. Data and Variables

This study uses annual data from the Profit and Loss Statements and the Balance Sheets of Indian corporate manufacturing firms listed in the Bombay Stock Exchange Official Directory. Firms are classified according to two broad industrial categories: Electronics, Electrical Equipment and Cables (EEEC) and General Engineering (GE). These two manufacturing industries are selected based on two observations: first, the maximum number of firms that we could obtain in any industry category; and secondly, in the post-liberalization period the longest time period that we could capture in our empirical study. One of the major drawbacks of the data in this Directory is the inconsistency in the reporting year of some firms. Therefore, for a balanced panel we could include a smaller number of firms. For instance, in EEEC although there are a total of 39 firms listed in the March-April, 2000, Vol. 15, of the Bombay Stock Exchange Official Directory, we could filter out only 26 firms for our empirical study.

The balanced panel for EEEC covers a 7-year period from 1991-92 to 1997-98 with observations on 26 firms, a total of 182 (26×7) observations. Construction of the lagged variables extend the data period backwards into 1989-90. On the other hand, in GE although 33 firms are listed in the September-October, 2000, Vol. 13 of the Directory, we could filter out only 28 firms covering a

6-year period from 1993-94 to 1998-99 for our empirical study, leaving us with 168 (28×6) observations. The lagged variables extend the data period backwards up to 1990-91.

The firms in EEEC produce various industrial electronic equipments, electronic communication equipments, generators, transformers, electric motors, furnaces, etc. The selected 26 firms in EEEC have heterogeneous product categories. GE data contains relatively more multi-product firms. In some cases firms have very distantly related products. The 28 selected firms produce a wide range of machines and machine tools, and consumer durables. In these two industries, the movements in firms' (nominal as well as real) net sales depict that all average values are much higher in GE, although the average annual percentage change over the years is bigger in EEEC.[6] Therefore, firms may be relatively bigger in size in GE, the over all growth of EEEC firms is more impressive.

We define nominal Net Investment as the change in the Net Fixed Assets (NFA) over two successive periods. The real values of all variables are obtained by dividing the nominal values in a year by the year-end WPI. Similar to Audretsch and Elston (2002), and Bond *et al*. (2003) real sales values have been used in this study as a proxy for output.[7]

Accumulated depreciation allowances and retained earnings are the two main internal sources of finance to a firm. Depreciation allowances are set aside primarily to replace the worn-out capital; where as retained earnings can be entirely used for new capital formation. See Chandra (2001). Our measures of internal liquidity are based on retained earnings which we find more relevant for *net* investment decisions of firms. Two variants of retained earnings are used in the regressions, namely the volume of retained earnings (RE) and retained earnings ratio (RER). Retained earnings is obtained from net profit. RER is measured as the ratio of retained earnings over net profit. One can obtain the dividend-payout ratio by deducting RER from unity. The purpose behind including RER is to examine whether retention practice vis-à-vis dividend-payout decision is important to our selected sample of firms, in addition to the issue whether the volume of retained earnings that is available for investment is more important than firm retention

[6] See, Appendix I. We report summary statistics of the selected variables. Summary statistics of other variables are available on request from the author.
[7] A more accurate measure of output could have been obtained by adding final goods inventories to the sales figures. However, inventory values of final goods for all selected firms for all the years are not available in the Directory.

practice.[8] If the decision to pay dividends overrides savings motives of firms, volume of retained earnings will be determined residually. In other words, retention practices of firms will take a backseat. Therefore, the variable RER is expected to shed some light on this issue.

We do not follow the existing practice in empirical studies where investment and liquidity variables are often deflated by the beginning of the period capital stock.[9] We believe that in the presence of market imperfection, the volume of RE is all the more important. In other words, what is relatively more relevant to firms' decision-making processes is the *quantum* of liquidity (RE) that is available internally in relation to the *quantum* of new additions per unit of capital stock, beside the decision to pay dividend vis-à-vis retaining profits for liquidity purpose (RER).[10]

IV.1 Empirical Models

Our choice of empirical models is largely guided by the availability of data. For instance, unavailability of data does not allow us to measure user cost of capital. Hence, in our regressions we ignore any independent role of user cost. Binswanger (1999, p.212) pointed out that, "… the cost of capital (and interest rates) has usually not performed well in empirical tests, and other variables, such as output, sales or profits, proved to be more relevant". Fazzari and Peterson (1993) also found that the cost of capital effect is small compared to the strong effect of the accelerator. In the presence of such restrictions our empirical equations will not conform to the exact form of the algebraic relationships that have been obtained in Section II. However, all empirical models will have two common features: one period lagged dependent variable to bring in the short-run dynamism that is expected to exist in real world investment activities; and current and one period lagged accelerators in order to examine the influence of the present and immediate past, on current investment activities of firms.

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[8] Fazzari *et al*. (1988) among others classified firms according to their retention practices. We are unable to classify firms in a similar fashion due to the smallness of our sample, but directly test for the significance of retention practice in firm investment.

[9] One possible reason behind this practice in the literature could be to tackle the common problem of heteroskedasticity. Since we use the White (1980) corrected consistent covariance matrix estimator to obtain the heteroskedasticity corrected standard errors, we felt there is no further need to deflate the variables again by a scale variable like capital stock to tackle the problem of heteroskedasticity.

[10] This is another reason why we do not deflate the liquidity variables by last period capital stock. There exist quite a few empirical studies which had done so. See for example, Tybout (1983), Fazzari and Athey (1987), Nabi (1989) and Eastwood and Kohli (1999).

Table I lists the four empirical models. The nominal investment functions are similar to the Neoclassical Nominal Accelerator Model II. And the real investment functions are similar to the Neoclassical Real Accelerator Model I. The other two models are not estimated because of the measurement problem with respect to real capital. The Stock Exchange Directory provides us with information on $\widetilde{K}$ which allows us to obtain $\widehat{K}$ using WPI. It does not contain information on *K*.

The general form of the two-way panel data regression equation to be used will be

1.13 $$z_{it} = \alpha_i + \upsilon_t + \gamma_1 x_{it} + \gamma_2 x_{i,t-1} + \gamma_3 z_{i,t-1} + \varepsilon_{it}$$

where z_{it} is a measure of investment and x_{it} is a measure of accelerator. α_i contains the firm specific effects and υ_t the time specific effects. ε_{it} is the white noise error term. Firm specific effects can be due to unobserved entrepreneurial or managerial skills of the firm's management. They can also represent other things like the user cost differentials; see Bond *et al*. (2003). The time specific effects on the other hand, can account for strike year effects that disrupt investment, delivery lags in receiving capital goods, etc. see Samuel (1996).

Table I: Empirical Models

Nominal Net Investment Function I:	$\widetilde{i}_{i,t}^{N} = \alpha_i + \upsilon_t + \gamma_1 s_{it} + \gamma_2 s_{i,t-1} + \gamma_3 \widetilde{i_{i,t-1}^{N}} + \varepsilon_{it}$
Nominal Net Investment Function II:	$\widetilde{I}_{i,t}^{N} = \alpha_i + \upsilon_t + \gamma_1 \Delta S_{it} + \gamma_2 \Delta S_{i,t-1} + \gamma_3 \widetilde{I_{i,t-1}^{N}} + \varepsilon_{it}$
Real Net Investment Function I:	$\hat{i}_{i,t}^{N} = \alpha_i + \upsilon_t + \gamma_1 \hat{s}_{it} + \gamma_2 \hat{s}_{i,t-1} + \gamma_3 \hat{i}_{i,t-1}^{N} + \varepsilon_{it}$
Real Net Investment Function II:	$\hat{I}_{i,t}^{N} = \alpha_i + \upsilon_t + \gamma_1 \Delta \widehat{S}_{it} + \gamma_2 \Delta \widehat{S}_{i,t-1} + \gamma_3 \hat{I}_{i,t-1}^{N} + \varepsilon_{it}$

All variables follow their definitions as discussed in Section II.

V. Estimation Method

In our empirical study we use panel data consisting of pooled time series of cross sections in which one has repeated observations on the cross-section units (firms) over time. Initially, using the SAS software, we try both types of alternative panel data models namely, Random Effects and Fixed Effects models. The Hausman (1978) specification test for REM and the F- test for FEM reject both these types of model specifications, and hence we plan to use the OLS method to estimate the empirical models. With limited time series observations it is difficult to find out whether errors are autocorrelated. In other words, each regression equation can be tested firm-wise for autocorrelation, but we do not have sufficient time series data to conduct Durbin's *h* test.

V.1 Specification Tests

Conventional regression specification assumes two properties: Orthogonality and Sphericality.

(a) Orthogonality: $E\langle u|X\rangle = 0$, where *E* denotes expectation, *u* is the vector of random error terms and *X* is the vector of explanatory variables.

(b) Sphericality: $V\langle u|X\rangle = \sigma^2 I$, where *V* denotes variance, σ^2 is the population variance and I is an identity matrix.

The 'orthogonality' property implies that the explanatory variables are not correlated with the random error terms, and hence exogenous to the model. It is the violation of 'orthogonality' property that leads to biased and inconsistent estimates, whereas if 'sphericality' is not satisfied then the estimator will not be efficient. In Section V.1.1 we mention failure of the orthogonality property of the regressors; and in Section V.1.2 we focus on the sphericality property of the error distribution.

V.1.1 Hausman *LM* Test

In a seminal paper, Hausman (1978) suggested a test of exogeneity of the regressors. We conduct exogeneity test on all the explanatory variables used in our regression models. The Hausman *LM* test statistic when compared with the χ^2 value with 1 *df*, indicates whether an explanatory variable is exogenous or not. Under H_0, *LM* asymptotically approaches χ^2 distribution with 1 degree of freedom (*df*). If H_0 is rejected, then the concerned explanatory variable is endogenous at a particular significance level. The Hausman *LM* Test results are given in Appendix II.

V.1.2 White Correction

One of the classical assumptions of the standard linear regression model is that the variance of the disturbance term is constant (or homogenous) across observations. If this assumption is violated then the error term is said to be heteroskedastic. If the extent of heteroskedasticity is mild, OLS standard errors behave quite well; see Long and Ervin (2000). However, when heteroskedasticity is severe, ignoring it may bias our standard errors and concerned *p* values. White (1980) resolved this problem by obtaining a covariance matrix estimator that is consistent even in the presence of heteroskedasticity that does not depend on any specific heteroskedastic structure of the error term. Consider the following model $Y = X\beta + \varepsilon$ where X is a $n \times K$ matrix, Y is a $n \times 1$ vector, and ε is the $n \times 1$ vector of random errors. Assuming that X and ε are uncorrelated, let us define the OLS estimator as $\widehat{\beta} = (X'X)^{-1} X'Y$. Now consider the vector of the estimated residuals $\hat{\varepsilon} = Y - X\widehat{\beta}$, which holds the key to obtaining the following heteroskedasticity-consistent covariance estimator

$$(X'X)^{-1}\left(X'diag\left(\hat{\varepsilon}^{2}\right)X\right)(X'X)^{-1}Y$$

White (ibid.) proved that using this estimator to test the linear hypotheses would give correct results asymptotically. The corrected standard errors are square root of the diagonal elements of the matrix shown above.

VI. Empirical Results

The regression results appear in Tables II – V. In case of endogenous explanatory variables, we use the predicted values of the variables from the regressions of these variables on their respective *instruments*, as regressors in the regressions.[11] Assuming that there is some degree of heteroskedasticity present in our data, we obtain the White (1980) corrected *t*-ratios of all parameter estimates. We use 0.7 as the cut-off correlation coefficient among the explanatory variables to retain the right hand side variables in the regressions. Therefore, the reported results contain only those (significant) variables among which the correlation coefficient is less than or equal to 0.7, thereby indicating absence of any serious multicollinearity among them. Also, the following tables contain only those parameter estimates and their corresponding White corrected t-values, which are statistically significant at least at five percent (two-tailed test).

The regression estimates from Nominal Net Investment Function I are shown in Table II. The current accelerator is significant in EEEC, where as the lagged accelerator is significant in GE with expected signs. This indicates that in GE, sales affect net investment only with a lag.[12] The strength of the current accelerator and the lagged accelerator alter only marginally with the inclusion of liquidity. In EEEC the lagged accelerator which was not significant in the

[11] The Hausman *LM* Test reveals that none of the (*nomina*l as well as *real*) liquidity variables are endogenous.
[12] We have not investigated into the effects of sales beyond two periods primarily to avoid any further reduction in the number of observations. Recall our discussion where it was pointed out that not only the number of reporting firms is quite small, the sample size had to be reduced further to establish a reasonable clarity among the firms from several points of view, for instance uniformity in the reporting months of the firms.

accelerator model, becomes significant in the presence of the liquidity variables. The coefficient of the current accelerator is greater than the coefficient of the lagged accelerator, implying that in EEEC the effect of the current accelerator induced investment is stronger than that of the lagged accelerator. In both the industries, only the one period lagged liquidity (RER or RE) is statistically significant. Both retained earnings *ratio* and *volume* of retained earnings are positively related to nominal investment rate. The lagged dependent variable is statistically significant in both the industries implying that investment is a dynamic phenomenon. However, it becomes insignificant in either industry with the inclusion of the liquidity variables.

Table II
Nominal (Net) Investment Function I with Accelerator(s) and Internal Liquidity
Table II.1: Electronics, Electrical Equipment and Cables

(White corrected *t* statistic in parenthesis)

Accelerator Model: $\widetilde{i_t^N} = \underset{(4.10)^a}{0.22} + \underset{(1.92)^b}{0.12}\, \widetilde{i_{t-1}^N} + \underset{(2.06)^b}{0.31}\, s_t$; $\overline{R}^2 = 0.09$; $N = 182$

RER Model: $\widetilde{i_t^N} = \underset{(1.98)^b}{0.33}\ s_t + \underset{(2.68)^a}{0.07}\ s_{t-1} + \underset{(1.87)^b}{0.32}\ \text{Liquidity}_{t\text{-}1}$; $\overline{R}^2 = 0.10$; $N = 182$

RE Model: $\widetilde{i_t^N} = \underset{(2.13)^b}{0.33}\, s_t + \underset{(2.66)^a}{0.08}\, s_{t-1} + \underset{(1.87)^b}{1.87\text{E}-07}\ \text{Liquidity}_{t\text{-}1}$; $\overline{R}^2 = 0.09$; $N = 182$

Table II.2: General Engineering

Accelerator Model: $\widetilde{i_t^N} = \underset{(3.03)^a}{0.07} + \underset{(2.58)^a}{0.28}\ \widetilde{i_{t-1}^N} + \underset{(1.83)^b}{0.25}\ s_{t-1}$; $\overline{R}^2 = 0.09$; $N = 168$

RER Model: $\widetilde{i_t^N} = \underset{(1.86)^b}{0.24}\ s_{t-1} + \underset{(1.84)^b}{0.14}\ \text{Liquidity}_{t-1}$; $\overline{R}^2 = 0.07$; $N = 168$

RE Model: $\widetilde{i_t^N} = \underset{(2.10)^b}{0.27}\ s_{t-1} + \underset{(2.54)^a}{4.07\text{E}-08}\ \text{Liquidity}_{t-1}$; $\overline{R}^2 = 0.07$; $N = 168$

a: significant at 1%; b: significant at 5%.

Table III contains parameter estimates from Nominal Net Investment Function II. The current sales accelerator is positively significant in EEEC. In GE the lagged accelerator remains significant. Additionally, with the inclusion of liquidity there is evidence in favor of the lagged accelerator in EEEC and the current accelerator in GE. The effect of current sales induced investment remains relatively stronger in EEEC while the lagged accelerator is relatively dominant in GE, even with the inclusion of the liquidity variables. Unlike the previous model, only the 2-period lagged liquidity variables are statistically significant in this model in both the industries. While in EEEC both the alternative liquidity variables (RER and RE) are significant determinants of level of investment, only RE is significant for GE firms. What we have observed with respect to the RER model for GE is that none of the two lagged RER variables is statistically significant in isolation of the other. In the presence of the 1-period lagged RER, the 2-period lagged RER is statistically significant at 5%. However, since the 1-period lagged liquidity is statistically insignificant, dropping it from the regression renders the 2-period lagged RER insignificant as well.[13] The lagged dependent variable is significant only in the RER model for EEEC; in the RE models in both the industries the lagged dependent variable has been replaced by the accelerators and liquidity variables.

Table III
Nominal (Net) Investment Function II with Accelerator(s) and Internal Liquidity
Table III.1: Electronics, Electrical Equipment and Cables

(White corrected *t* statistic in parenthesis)

Accelerator Model: $\widetilde{I_t^N} = \underset{(4.09)^a}{0.65}\ \widetilde{I_{t\text{-}1}^N} + \underset{(2.82)^a}{0.26}\ \Delta S_t + \underset{(1.69)^b}{0.08}\ \Delta S_{t-1}$; $\overline{R}^2 = 0.30$; $N = 182$

RER Model: $\widetilde{I_t^N} = \underset{(2.46)^a}{-326220} + \underset{(4.16)^a}{0.61}\ \widetilde{I_{t\text{-}1}^N} + \underset{(2.85)^b}{0.26}\ \Delta S_t + \underset{(1.90)^b}{0.09}\ \Delta S_{t-1} + \underset{(2.42)^a}{387775}\ \text{Liquidity}_{t-2}$; $\overline{R}^2 = 0.31$; $N = 182$

RE Model: $\widetilde{I_t^N} = \underset{(2.00)^a}{-99740} + \underset{(3.27)^a}{0.24}\ \Delta S_t + \underset{(3.45)^a}{2.27}\ \Delta S_{t-1}$; $\overline{R}^2 = 0.47$; $N = 182$

a: significant at 1%; b: significant at 5%.

[13] When the 1-period lagged liquidity is not important, why the 2-period lagged liquidity is significant for current investment? Although we find it difficult to interpret this finding in terms of economic theory, one can only say that the 'level' of investment is determined by internal funds available two-period back. Indeed, it remains a question that why the availability of liquidity in the immediate past is not important in deciding the 'level' of investment expenditures. One interpretation may be that firms maintain the cash flow of immediate past to support (if needed) their current operating cost and use up accumulated internal funds available two-period back to help financing new investment. And, since the available cash flow is *net* of dividend payments, interest payments and tax payments the firms want them to grow for distant future (use). Therefore, by not using the liquidity from immediate past the firms can give extra time to that liquidity to grow further and instead use the internal funds available previous to the immediate past to finance current investment expenditures.

Table III.2: General Engineering

Accelerator Model: $\widetilde{I_t^N} = \underset{(2.00)^a}{0.79}\ \widetilde{I_{t-1}^N} + \underset{(2.53)^a}{0.10}\ \Delta S_{t-1}\ ;\ \overline{R}^2 = 0.79;\ N = 168$

RE Model: $\widetilde{I_t^N} = \underset{(1.83)^b}{0.07}\ \Delta S_t + \underset{(2.96)^a}{0.16}\ \Delta S_{t-1} + \underset{(3.99)^a}{1.27}\ \text{Liquidity}_{t-2};\ \overline{R}^2 = 0.63;\ N = 168$

a: significant at 1%; b: significant at 5%.

From the tables on nominal net investment functions, two main observations can be made on the role of accelerator and internally available liquidity in net investment activities of firms in the selected sample. First, in most cases, both the internal liquidity variables (RER as well as RE) along with the accelerator(s) are statistically significant determinants of net investment activities of Indian manufacturing firms. In one case (Nominal Net Investment Function II in GE) RE is the only significant liquidity variable. Second, in all the reported regressions, only one of the two lagged liquidity variables is important for current investment decisions.

We now turn to the real net investment functions. The parameter estimates from Real Net Investment Function I are reported in Table IV. This model produces statistically meaningful results only for EEEC. The result for EEEC is very similar to its nominal net investment counterpart. The current (real) accelerator and the lagged dependent variable explains current rate of real net investment with similar coefficient values. The lagged accelerator surfaces only in the nominal RE model. However, the model is a poor fit for GE, hence not reported here. None of the explanatory variables are found statistically significant. There is also high correlation among the lagged liquidity variables in GE. The hint of a lagged effect of sales accelerator on investment in earlier models warrants the presence of a two-period lagged accelerator in the regression. Unfortunately, our data set limits testing this hypothesis. Except for the real RE model, only the first lagged liquidity variables are significant in the liquidity models. As before, the lagged dependent variable has been replaced by internal liquidity.

Table IV
Real (Net) Investment Function I with Accelerator(s) and Internal Liquidity
Table IV.1: Electronics, Electrical Equipment and Cables

(White corrected *t* statistic in parenthesis)

Accelerator Model: $\widehat{i_t^N} = \underset{(3.66)^a}{0.15} + \underset{(1.93)^b}{0.11}\ \widehat{i_{t-1}^N} + \underset{(2.08)^b}{0.32}\ \widehat{s_t}$; $\overline{R}^2 = 0.09$; $N = 182$

RER Model: $\widehat{i_t^N} = \underset{(1.96)^b}{0.33}\ \widehat{s_t} + \underset{(2.13)^b}{0.33}\ \text{Liquidity}_{t\text{-}1}$; $\overline{R}^2 = 0.09$; $N = 182$

RE Model: $\widehat{i_t^N} = \underset{(3.27)^a}{0.14} + \underset{(2.15)^b}{0.34}\ \widehat{s_t} + \underset{(2.68)^a}{0.07}\ \widehat{s_{t-1}} + \underset{(1.97)^a}{1.90\text{E}-07}\ \text{Liquidity}_{t\text{-}1}$; $\overline{R}^2 = 0.09$; $N = 182$

a: significant at 1%; b: significant at 5%.

Finally, the statistical fit of Real Net Investment Function II can be seen from Table V. The results are very similar to what we have seen earlier. The current accelerator is significant in EEEC, where as in GE the lagged accelerator affects current net investment. In GE, the effect of lagged accelerator becomes stronger in the presence of internal liquidity variable(s). The liquidity variables with a 2- period lag are found statistically significant in EEEC under the three different liquidity specifications: RER, *nominal* and *real* RE. However, in GE the 2- period lagged liquidity variables are significant in the RE models: *nominal* and *real* RE. The liquidity variable(s) under RER specification is not significant in GE. In this industry high correlation has been observed between 2-lagged RE and the lagged dependent variable. Therefore, the reported results in GE are obtained after dropping the lagged dependent variable. The lagged dependent variable is consistently found significant in EEEC.

Table V
Real (Net) Investment Function II with Accelerator(s) and Internal Liquidity
Table: V.1: Electronics, Electrical Equipment and Cables

(White corrected *t* statistic in parenthesis)

Accelerator Model: $\widehat{I_t^N} = \underset{(4.43)^a}{0.68}\ \widehat{I_{t\text{-}1}^N} + \underset{(2.58)^a}{0.23}\ \Delta\widehat{S_t}\ ;\quad \overline{R}^2 = 0.26;\ N = 182$

RER Model: $\widehat{I_t^N} = \underset{(1.70)^b}{-1531.34} + \underset{(4.47)^a}{0.65}\ \widehat{I_{t\text{-}1}^N} + \underset{(2.61)^a}{0.23}\ \Delta\widehat{S_t} + \underset{(2.09)^b}{2527.37}\ \text{Liquidity}_{t-2};\ \overline{R}^2 = 0.26;\ N = 182$

RE Model: $\widehat{I_t^N} = \underset{(2.23)^b}{-738.29} + \underset{(1.83)^a}{0.23}\ \widehat{I_{t\text{-}1}^N} + \underset{(3.14)^a}{0.22}\ \Delta\widehat{S_t} + \underset{(2.98)^a}{0.01}\ \text{Liquidity}_{t-2};\ \overline{R}^2 = 0.42;\ N = 182$

Real RE Model: $\widehat{I_t^N} = \underset{(2.27)^b}{-888.66} + \underset{(2.09)^b}{0.26}\ \widehat{I_{t\text{-}1}^N} + \underset{(3.11)^a}{0.21}\ \Delta\widehat{S_t} + \underset{(2.95)^a}{1.58}\ \text{Liquidity}_{t-2};\ \overline{R}^2 = 0.41;\ N = 182$

Table V.2: General Engineering

Accelerator Model: $\widehat{I_t^N} = \underset{(5.28)^a}{0.69}\ \widehat{I_{t\text{-}1}^N} + \underset{(2.66)^a}{0.11}\ \Delta\widehat{S_{t-1}}\ ;\ \overline{R}^2 = 0.66;\ N = 168$

RE Model: $\widehat{I_t^N} = \underset{(3.89)^a}{0.18}\ \Delta\widehat{S_{t-1}} + \underset{(4.06)^a}{0.008}\ \text{Liquidity}_{t-2}\ ;\ \overline{R}^2 = 0.52;\ N = 168$

Real RE Model: $\widehat{I_t^N} = \underset{(3.74)^a}{0.17}\ \Delta\widehat{S_{t-1}} + \underset{(4.18)^a}{1.00}\ \text{Liquidity}_{t\text{-}2}\ ;\ \overline{R}^2 = 0.54;\ N = 168$

a: significant at 1%; b: significant at 5%.

From the above seven tables, four for EEEC and three for GE, with different specifications of the dependent variable: *nominal* and *real*, *rate* and *level*, we conclude the following.

(a) Only one of the two liquidity variables has been found significant in the models with liquidity. Out of a total of 14 regressions, the 1-period lagged liquidity has been statistically significant six times: four times in EEEC and twice in GE. In the remaining eight regressions, the 2-period lagged liquidity has been found statistically significant five times in EEEC and thrice in GE. Therefore, *availability of internal liquidity for investment in fixed capital is more important in EEEC than GE.*

(b) In most of the regressions, RE performs relatively better than RER. This can be interpreted by saying that the *quantum of internally generated funds is relatively more important than firm* *retention decisions*. Nevertheless, presence of RER in 5 out of a total 14 regressions indicates some evidence in favor of firms being more concerned about retention ratio than their dividend payout ratio.

(c) Under any model specification with liquidity, the current accelerator has remained consistently significant in EEEC with stable coefficient values. However, the lagged accelerator has not been so persistent in EEEC across the different models. On the other hand, the presence of the lagged accelerator is not only consistent in GE but has become stronger with the inclusion of liquidity.

VII. Profitability and Financial Strength

The preceding discussion revealed that retained earnings is one of the major determinants of corporate fixed investment, thereby indicating imperfections in the Indian capital market. In this section, we first explore the role of profitability in place of liquidity in firms' new investment decisions. Second, we test the role of firms' financial strength in new investment decisions.

There can be two alternative justifications for including profitability in the regression. One is to test empirically the source of internal funds itself, that is, net profits. With this interpretation we go one step backward! Our objective will be to see whether *undistributed* 'net profit per unit of net sales' affects firm investment or not, as opposed to the conventional wisdom that firms decisions regarding dividend-payouts vis-à-vis retained earnings and the volume of retained earnings are significant for new investment projects. We hypothesize that *increase in last period's profitability induces current net investment*. The other argument is that recent profitability of firms signal expected future profits that can affect firms' investments. This emphasizes the forward-looking nature of investment decisions. We also explore firms' accessibility to *external* capital and its relation to net investment activities. The financial strength of firms determines their credit worthiness in the external capital market. Does previous period's *financial strength* influence firms' current investment decisions? We measure financial strength (FINS) as $\left(\frac{\text{Net Worth}}{\text{Total Assets}}\right)_{t-1}$, commonly referred to as the 'proprietary ratio'.[14]

[14] One can obtain the 'ratio of total liabilities to total assets' by deducting the proprietary ratio from unity. Therefore, the financial strength variable shows the importance of assets financed by equity in relation to borrowed funds, indicating the 'margin of safety' for creditors. The higher the proprietary ratio, the stronger is the financial position of the company and the more satisfactory is its financial structure from the point of view of creditors. In this sense, this ratio measures the credit worthiness of firms to outside creditors.

The descriptive statistics of the financial strength variable in the two industries reveal that the GE firms are marginally bigger than their EEEC counterparts. It appears that the GE firms are relatively more credit worthy than the EEEC firms. See Table 4, Appendix I.

VII.1 Evidence on Profitability and Financial Strength

The regression results with profitability and financial strength are discussed here. We maintain the same judgments to select models as discussed in Section VI. The Hausman *LM* test found profitability and financial strength variables exogenous in GE throughout. However, in EEEC profitability is found endogenous, although financial strength is exogenous across alternative models. See Table 2, Appendix II.

The statistical fit of Nominal Net Investment Function I is shown in 1.14. Profitability is significant only in EEEC. In comparison to the liquidity models, the coefficient of the current accelerator marginally weakens, while the lagged accelerator remains stable.

1.14

$$\left.\widetilde{i_t^N}\right|_{\text{EEEC}} = \underset{(2.55)^a}{0.14} + \underset{(1.83)^b}{0.30\, s_t} + \underset{(2.12)^b}{0.07 s_{t-1}} + \underset{(2.42)^a}{1.54\ \text{Profitability}_{t\text{-}1}}$$

$$\overline{R}^2 = 0.11;\quad N = 182$$

a: significant at 1%; b: significant at 5%. White corrected *t* statistic in parenthesis.

In both the industries, the financial strength variable does not perform satisfactorily when we estimate Nominal Net Investment Function I. 1.15 reports the performance of Nominal Net Investment Function II with profitability. The profitability model competes well with the RER model in EEEC. The current and lagged accelerator coefficients are same. Even in comparison to the RE model, the current accelerator remains quite stable. However, the coefficient of the lagged dependent variable is relatively smaller than the RER model. Profitability is again found statistically insignificant in GE, hence not reported here.

1.15

$$\left.\widetilde{I_t^N}\right|_{\text{EEEC}} = \underset{(2.32)^{\text{a}}}{-147652} + \underset{(2.79)^{\text{a}}}{0.26\, \Delta S_t} + \underset{(1.89)^{\text{b}}}{0.09\, \Delta S_{t-1}} + \underset{(3.78)^{\text{a}}}{0.54\, \widetilde{I_{t-1}^N}} + \underset{(2.17)^{\text{b}}}{1734005\ \text{Profitability}_{t-1}}$$

$$\overline{R}^2 = 0.32;\quad N = 182$$

a: significant at 1%; b: significant at 5%. White corrected *t* statistic in parenthesis.

The regression estimates of Nominal Investment Function II with financial strength are reported in 1.16. Financial strength affects net investment positively in EEEC, whereas it is statistically insignificant in GE. Recall that the GE firms are relatively bigger and more credit-worthy than the EEEC firms. In other words, EEEC firms are relatively more credit constrained than their GE counterparts. The current and lagged accelerators maintain similar coefficients in the presence of financial strength. However, the coefficient value of the lagged dependent variable decreases in the presence of financial strength.

1.16

$$\left.\widetilde{I_t^N}\right|_{\text{EEEC}} = \underset{(2.26)^b}{-253514} + \underset{(2.82)^a}{0.26\,\Delta S_t} + \underset{(2.02)^b}{0.10\,\Delta S_{t-1}} + \underset{(4.10)^a}{0.58\,\widetilde{I_{t-1}^N}} + \underset{(2.11)^b}{575348\,\text{FINS}_{t-1}}$$

$$\overline{R}^2 = 0.31; \quad N = 182$$

a: significant at 1%; b: significant at 5%. White corrected t statistic in parenthesis.

The Real Net investment Function I results with profitability are reported in 1.17. Inclusion of profitability still does not explain real net investment activities of GE firms. In EEEC, however, with the inclusion of profitability the effect of current accelerator becomes weaker compared to the liquidity models.

1.17

$$\left.\widehat{i_t^N}\right|_{\text{EEEC}} = \underset{(1.89)^b}{0.08} + \underset{(1.77)^b}{0.29\,\widehat{s_t}} + \underset{(2.76)^a}{1.58\,\text{Profitability}_{t-1}}$$

$$\overline{R}^2 = 0.10; \quad N = 182$$

a: significant at 1%; b: significant at 5%. White corrected t statistic in parenthesis.

In Real Net Investment Function I, financial strength (FINS) is statistically insignificant in both the industries. Recall that this model could not explain net investment activities of GE firms in earlier regressions.

Regression results from Real Net Investment Function II with profitability are shown in 1.18. As before, profitability is statistically significant only in EEEC; the GE results are therefore not reported. Inclusion of profitability retains stable coefficient of the current accelerator. The lagged dependent variable is significant and its coefficient is nearer to the value observed in the RER model. The intercept term which was statistically significant in the liquidity models is now insignificant with the inclusion of profitability.

1.18
$$\left.\widehat{I_t^N}\right|_{\text{EEEC}} = 0.22\ \Delta\widehat{S_t} + 0.60\ \widehat{I_{t-1}^N} + 11348\ \text{Profitability}_{t-1}$$
$$\qquad (2.57)^a \qquad (4.20)^a \qquad (1.82)^b$$
$$\overline{R}^2 = 0.27;\quad N = 182$$

a: significant at 1%; b: significant at 5%. White corrected t statistic in parenthesis.

The estimates from Real Net Investment Function II are shown in 1.19. Financial strength is positively significant only in EEEC. Similar to what we have witnessed in the nominal counterpart of this model, the accelerator remains stable with the inclusion of financial strength. However, the lagged dependent variable has become marginally weaker.

1.19
$$\left.\widehat{I_t^N}\right|_{\text{EEEC}} = 0.22\ \Delta\widehat{S_t} + 0.65\ \widehat{I_{t-1}^N} + 3874.98\ \text{FINS}_{t-1}$$
$$\qquad (2.58)^a \qquad (4.45)^a \qquad (1.83)^b$$
$$\overline{R}^2 = 0.27;\quad N = 182$$

a: significant at 1%; b: significant at 5%. White corrected t statistic in parenthesis.

Therefore, profitability can be a viable alternative to internal liquidity in determining nominal as well as real net investment, in one of the two industries. However, *internal liquidity is relatively more important than profitability when it comes to firms' net investment decisions* in both the industries. Only two investment models and that too only for one industry indicate statistical significance of financial strength of firms in their net investment decisions.

VIII. Conclusion

It is shown that acceleration principle is embedded within the neoclassical theory. Empirically, we attempted to explore that to what extent *market demand had been important in India in the first decade of liberalization process when availability of internal liquidity, firms' profitability and creditworthiness are considered*. The four alternative investment models have been derived so that on one hand, we can look into the determinants of both *nominal* and *real* investment decisions of (selected) Indian manufacturing firms. While on the other hand, the paper wanted to explore whether it is the *level* or *rate* of net investment that best explains the business fixed investment activity of the selected Indian manufacturing firms.

Availability of internal liquidity is one of the important determinants of net investment activities of Indian manufacturing firms in the two selected industries. In fact, it complements the role of accelerator(s) in firm investment decisions. Volume of retained earnings is more important than the retention ratio; and retention practices of firms are relatively more important than their dividend payout decisions. Short-run profitability does not have consistent influence on investment decisions of firms. Financial strength vis-à-vis credit worthiness of firms to creditors is important for investment decisions in EEEC. GE firms being comparatively bigger are more credit worthy, and therefore, can access external capital with relatively more ease.

This research does not claim to identify all the important determinants of corporate fixed investment in India. We have incorporated a few in this study, some more can be considered in a future project. For instance, the role of stock market on Indian firms' investment activities. One way of taking into account the role of stock market is to incorporate Tobin's *q*. However, there exist plenty of evidences that estimating *q* in a developing country context is too problematic. "Numerous practical difficulties arise in measuring Tobin's *q*, especially in a developing country context", Kumar *et al*. (2001, p. 138). Also see, Chatelain (2002) for a brief analysis of specific problems related to the *q* model.

Our choice of empirical models has been largely guided by the availability of data. Despite its popularity with extant researchers like Athey and Laumas, the data from recent issues of the BSE Directory have not allowed us to measure user cost of capital and output of firms among other things like classification of firms into small, medium and large size groups. The smallness of sample size has prevented us from constructing interactive variables which combine two or more features of firm investment behavior. For instance, whether relatively more credit worthy firms equally depend upon internal liquidity.

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Appendix I

Table 1: Nominal Net Sales

Table 1.1: Electronics, Electrical Equipment and Cables

Year	Mean (‘000 crores)	Median (‘000 crores)	Max. Value (‘000 crores)	Min. Value (‘000 crores)	SD
1989-90	1272212	795676.5	6538139	15951	1515964.2
1990-91	1607567	1051100	7370604	30037	1845629
1991-92	1955652	1269511	7448675	46249	2108512
1992-93	2274264	1400603	7970328	100851	2289076
1993-94	2803247	1422956	11619350	194081	3035175
1994-95	3692769	1804282	15250479	216154	3963120
1995-96	4681263	2184011	16387526	288584	4907674
1996-97	5278322	2343960	17514059	314133	5442443
1997-98	5491173	3004087	21077608	316962	5602912
Average (all years)	3228497	1697354	12352974	169222.4	3412278.3
Avg. annual change (%)	20.36	18.52	16.56	50.93	18.17

Total number of firms in each year: 26

Table 1.2: General Engineering

Year	Mean (‘000 crores)	Median (‘000 crores)	Max. Value (‘000 crores)	Min. Value (‘000 crores)	SD
1991-92	4748821	1968877	30846900	350540	6713289
1992-93	5046887	2330971	30250800	306375	6988086
1993-94	6007452	2081471	37041000	363486	8639562
1994-95	7736224	2231701	56698300	483826	12193586
1995-96	10013967	2645084	78657000	643280	16577861
1996-97	12058538	3199199	97683200	638408	20624526
1997-98	11453406	3014888	73270500	528678	17642310
1998-99	12279511	3268427	72500400	546060	18665862
Average (all years)	8668101	2592577	59618512.5	482581.63	13505635.2
Avg. annual change (%)	15.16	8.15	15.78	8.21	17.22

Total number of firms in each year: 28

Table 2: Retained Earnings$_{t-1}$

Table 2.1: Electronics, Electrical Equipment and Cables

Year	Mean	Median	Max. Value	Min. Value	SD
1990-91	50479.77	21826	246309	0	71350.93
1991-92	75610.73	18574	619957	0	126670.7
1992-93	93295.58	29879	406413	2628	110507.7
1993-94	130230.6	43247.5	750633	0	175759.8
1994-95	159090.7	56628	885808	0	220253.2
1995-96	231534.4	108521	1300662	0	319439.8
1996-97	164085.5	61303	853453	0	215097.6
Average (all years)	129189.6	48568.36	723319.3	375.43	177011.4
Avg. annual change (%)	25.22	28.29	38.73	–	26.92

Total number of firms in each year: 26

Table 2.2: General Engineering

Year	Mean	Median	Max. Value	Min. Value	SD
1992-93	77702.03	16697.5	474186	0	128854.5
1993-94	184968.75	47663	1160712	0	297135.6
1994-95	394629.86	111033	2479651	0	659647
1995-96	526475.9	127842.5	3628200	232	960036.3
1996-97	627931.79	111396.5	5499400	0	1229338
1997-98	521470.29	74696.5	3575168	0	952950.8
Average (all years)	388863.1	81554.83	2802886	38.67	704660.3
Avg. annual change (%)	57.42	57.55	64.26	–	60.74

Total number of firms in each year: 28

Table 3: Profitability$_{t-1}$

Table 3.1: Electronics, Electrical Equipment and Cables

Year	Mean	Median	Max. Value	Min. Value	SD
1990-91	0.05	0.04	0.30	-0.05	0.06
1991-92	0.06	0.03	0.28	-0.01	0.06
1992-93	0.07	0.04	0.30	0.01	0.07
1993-94	0.07	0.04	0.35	-0.08	0.08
1994-95	0.08	0.05	0.34	0.01	0.07
1995-96	0.08	0.06	0.27	-0.003	0.06
1996-97	0.06	0.05	0.33	-0.09	0.07
Average (all years)	0.07	0.04	0.31	–0.03	0.07
Avg. annual change (%)	2.86	6.04	2.49	207.48	2.31

Total number of firms in each year: 26

Table 3.2: General Engineering

Year	Mean	Median	Max. Value	Min. Value	SD
1992-93	0.03	0.03	0.14	–0.17	0.06
1993-94	0.04	0.04	0.14	–0.06	0.04
1994-95	0.09	0.06	0.83	–0.04	0.15
1995-96	0.06	0.06	0.15	0.00015	0.03
1996-97	0.05	0.06	0.14	–0.21	0.06
1997-98	0.06	0.06	0.14	–0.009	0.04
Average (all years)	0.06	0.05	0.26	–0.08	0.06
Avg. annual change (%)	24.19	17.02	82.13	–28855.80	35.29

Total number of firms in each year: 28

Table 4: Financial Strength$_{t-1}$

Table 4.1: Electronics, Electrical Equipment and Cables

Year	Mean	Median	Max. Value	Min. Value	SD
1990-91	0.29	0.27	0.57	0.13	0.11
1991-92	0.29	0.26	0.52	0.05	0.13
1992-93	0.33	0.29	0.68	0.14	0.15
1993-94	0.38	0.37	0.71	0.08	0.17
1994-95	0.41	0.41	0.80	0.13	0.16
1995-96	0.41	0.46	0.65	0.14	0.15
1996-97	0.42	0.42	0.71	0.14	0.15
Average (all years)	0.36	0.35	0.66	0.12	0.15
Avg. annual change (%)	6.59	8.29	0.05	24.63	5.41

Total number of firms in each year: 26

Table 4.2: General Engineering

Year	Mean	Median	Max. Value	Min. Value	SD
1992-93	0.30	0.28	0.74	–0.18	0.19
1993-94	0.34	0.34	0.73	–0.18	0.19
1994-95	0.39	0.41	0.68	–0.20	0.17
1995-96	0.41	0.42	0.66	0.19	0.12
1996-97	0.43	0.40	0.73	0.15	0.12
1997-98	0.44	0.41	0.77	0.16	0.14
Average (all years)	0.38	0.38	0.72	–0.01	0.15
Avg. annual change (%)	7.99	8.10	1.14	–39.04	–4.03

Total number of firms in each year: 28

Appendix II

Table 1: Hausman *LM* Test Results

Variable	EEEC *LM* statistic	GE *LM* statistic
s_t	5.04	0.27
s_{t-1}	2.09	2.21
$\widetilde{i_{t-1}^N}$	2.15	10.68 [a]
ΔS_t	1.60	3.24
ΔS_{t-1}	7.60 [a]	2.36
$\widetilde{I_{t-1}^N}$	7.58 [a]	0.80
$\widehat{s_t}$	5.30	0.09
$\widehat{s_{t-1}}$	2.91	0.06
$\widehat{i_{t-1}^N}$	3.16	0.15
$\Delta\widehat{S_t}$	1.69	6.89 [a]
$\Delta\widehat{S_{t-1}}$	2.18	3.82
$\widehat{I_{t-1}^N}$	9.73 [a]	0.03

Critical value of χ^2 (1 *df*) = 6.63 (at 1%). a: the null hypothesis is rejected at 1%.

Table 2: Hausman *LM* Test of Profitability and Financial Strength

Table 2.1: Nominal Net Investment Function I

Variable	EEEC *LM* statistic	GE *LM* statistic
Profitability	10.09 [a]	0.55
FINS	2.76	0.64

Critical value of χ^2 (1 *df*) = 6.63 (at 1%). a: rejects the null hypothesis at 1%.

Table 2.2: Nominal Net Investment Function II

Variable	EEEC *LM* statistic	GE *LM* statistic
Profitability	6.66 [a]	3.94
FINS	5.89	1.87

Critical value of χ^2 (1 *df*) = 6.63 (at 1%). a: rejects the null hypothesis at 1%.

Table 2.3: Real Net Investment Function I

Variable	EEEC *LM* statistic	GE *LM* statistic
Profitability	10.65 [a]	2.30
FINS	2.79	1.04

Critical value of χ^2 (1 *df*) = 6.63 (at 1%). a: rejects the null hypothesis at 1%.

Table 2.4: Real Net Investment Function II

Variable	EEEC *LM* statistic	GE *LM* statistic
Profitability	6.76 [a]	3.30
FINS	5.83	1.61

Critical value of χ^2 (1 *df*) = 6.63 (at 1%). a: rejects the null hypothesis at 1%.